

Introduction

Tanegashima SLR station (GMSL station), located in the southwest of Japan, was established by Japan Aerospace Exploration Agency (JAXA) in 2004. This poster reports on a summary of recent activity at Tanegashima station, including current operation status and space debris tracking experiment results. In addition, orbit determination and prediction results are provided.

System Overview

Tanegashima station has the capability of ranging satellites with a laser retroreflector array (LRA) from low earth orbit to geostationary orbit, using the laser with 10 Hz repetition rate and 532 nm wavelength.

Telescope	
Aperture	1 m
Type	Cassegrain
Pointing Accuracy	< 2 arcsec
Laser	
Wavelength	532 nm
Pulse Width	Low Mode: < 60 ps High Mode: < 300 ps
Repetition Rate	10Hz
Maximum Energy	Low Mode: > 50 mJ/pulse High Mode: > 300 mJ/pulse
Detector	
Type	MCP-PMT



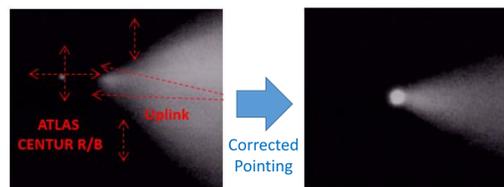
Space Debris Tracking Experiment

JAXA conducted an experiment of ranging space debris objects in recent years. Some returned signals were obtained from relatively large-sized debris objects without LRA, and their observation residuals was a level of a few meters. However, in either case a return rate was very low. Therefore, we are investigating ways to improve return rate.

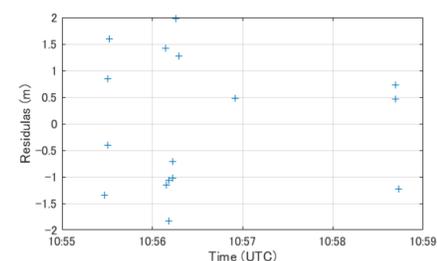
Experiment Conditions

- Target Object: Large-sized debris object without LRA in LEO
- Observation Timing: During early evening with the space debris objects still in sunlight, but with the GMSL station in darkness. This allowed us to correct the telescope pointing with a CCD camera installed on the telescope.
- Orbit Prediction Source: TLE or orbit determination results based on JAXA's radar observation
- Filter: Narrow band (532nm) filter was inserted to cut out sunlight induced noise.

Example of Results



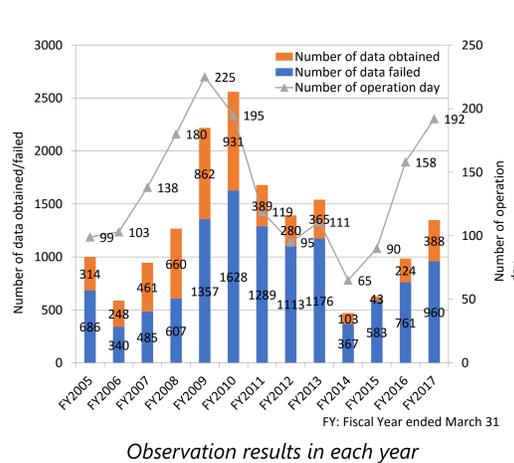
Tracking image through CCD camera
29th Dec. in 2017, ATLAS CENTUR R/B



Observation Residuals
6th Oct. in 2017, SL-16 R/B (RCS: 11.1m²)
Prediction Source: TLE

Operation Status

Current status of Tanegashima station is green and it is in operation throughout the year. On the other hand, Tanegashima station has been in quarantine over the last few years due to the temporary facility trouble. We have been trying to observe mainly LAGEOS1, 2, and LARES to acquire data needed for validation in quarantine procedure, however unfortunately a rainy climate of Tanegashima prevents us from that. It is regrettable that we cannot provide data to ILRS and contribute to geodesy. We have been continually working to efficiently acquire many data.



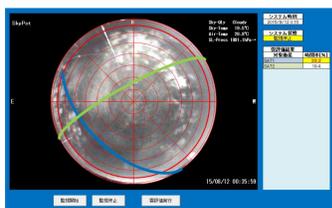
Observation results in each year

Observation results of each satellite

Satellite	Observation Mode	Data obtained	Observation trying pass
LAGEOS1	Low Mode	20	169
LAGEOS2	(High-Orbit)	31	188
Ajisaï(EGP)		60	149
CryoSat-2		7	32
GRACEB		0	2
GRACEA		0	12
JASON2		4	14
LARETS	Low Mode (Low-Orbit)	23	73
STARLETTE		45	92
STELLA		38	81
BEC		63	111
TanDEM-X		4	53
LARES		35	154
QZS1		7	17
QZS2		32	97
QZS3	High Mode (Geo-Orbit)	10	48
QZS4		9	56
Total		311	1888

Working to acquire more data

- Installed a whole sky camera to select an observation object whose pass is not obscured by cloud.
- Increased operation time per day in a period of relatively good weather season.



Cloud monitoring system

Orbit Determination and Prediction

In addition to acquiring ranging data, JAXA estimates the orbit of LAGEOS1, 2, and Ajisaï using our flight dynamics system, and distribute the predicted ephemerides (CPF) every day.

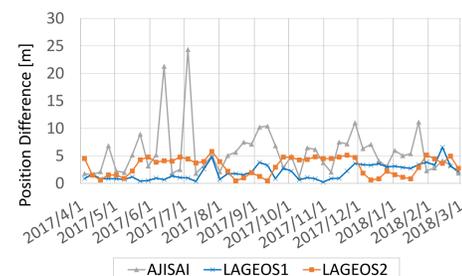
Orbit Determination

- Orbit determination is conducted every day.
- OD arc length:
LAGEOS1,2 8days
Ajisaï 5days
- RMS of residuals (O-C) of orbit determination is stable within a few centimeters.

Orbit Prediction

- Prediction Period: 4 days
- Precision of the CPF is evaluated once a week and the results (right figure) show that the CPF have a sufficient accuracy for tracking satellites.

Estimation Parameter	
Item	Description
Orbital state vector	Position, Velocity
SRP coefficient	Every Satellite
Air drag coefficient	Only Ajisaï
Range bias	Each pass
Station position	Only some stations



Maximum value of difference between predicted and observed ephemeris

Summary and Future Plan

- Current status of Tanegashima station is normal and it is in operation throughout the year.
- Tanegashima station is in quarantine now. We are working in order to acquire sufficient data needed for validation in quarantine procedure.
- In an experiment of ranging space debris objects, some returned signals were obtained. The current challenge is to improve a return rate.
- JAXA provides CPF of LAGEOS1, 2, and Ajisaï with a sufficient accuracy every day.
- Because Tanegashima station gets old, we are planning to build a new SLR station by the end of 2020.

